THE TELEGRAPHIC JOURNAL.

VOL. I.—NO. 17.

DR. C. W. SIEMENS'S ELECTRICAL PYROMETER.

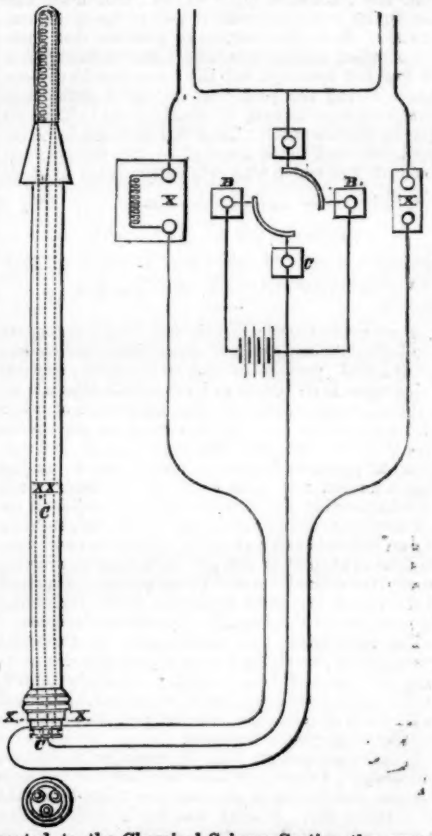
THE electrical resistance of metal conductors depends upon their dimensions, material, and upon their temperature; an increase of the latter causing a corresponding increase of resistance. The law of this increase is known. Thus, the resistance of a conductor being ascertained at 0° C., it can be calculated for any temperature, and, *vice versâ*, if the resistance can be found by measurement, the temperature can be calculated. This is the principle upon which the Electrical Pyrometer is based.

A platinum coil of a known resistance at 0° C. is coiled on a cylinder of fire-clay, protected by an iron or platinum tube, and is exposed to the temperature to be determined. Leading wires are arranged to connect this coil with an instrument suitable for measuring its resistance, and from this resistance the temperature can be calculated.

The instrument supplied for the purpose of measuring the resistance is a differential voltameter. The Differential Voltameter consists of two separate glass tubes, in each of which a mixture of sulphuric acid and water is decomposed by an electrical current passing between two platinum electrodes. The gas which is generated is collected in the long cylindrical and carefully-calibred top of the tube, and its quantity is read off by means of a graduated scale fixed behind the tubes. Movable reservoirs are provided, communicating with the tubes, to regulate the level of the liquid. The current of the battery is divided (by passing a commutator) into two circuits, one of which consists of an artificial resistance in the instrument and the platinum electrodes in one tube; the other, of the resistance to be measured and the electrodes in the other tube. The quantities of gas developed in the two tubes are in inverse proportion to the resistances of their respective circuits, therefore one of the resistances, viz., that in the instrument, being known, the other can be calculated.

When required for use, the battery glasses are filled with pure water, or, in case of the power of the battery decreasing, with a solution of sal-ammoniac in water. The poles are connected to B and B′ on the commutator. The small end of the tube, as far as the cone, is exposed to the heat to be measured, and the terminals x, x', c are connected to the ends of the leading cable bearing corresponding letters, and the other end of the leading cable to the terminals x, x', c on the voltameter. The differential voltameter is filled with the diluted sulphuric acid through the reservoirs, the india-rubber cushions being lifted from the top of the tubes. The commutator is then turned so that the contact springs on both sides rest on the ebonite. The liquid in both tubes is regulated to the same level (0° of scale), and the india-rubber cushions let down again. When the commutator is turned through a quarter of a circle on to the brass, the development of gas will commence almost immediately. The commutator should be turned half round every ten seconds to reverse the current. The current is kept passing until the liquid has fallen in the tubes to at least 50° of the scale, then put in its first position, so that the contact springs rest on the ebonite; the level of the liquids is read off on the scale, these numbers found in the table accompanying the instrument, and the intersecting point of the lines starting from these figures gives the resistance of the exposed coil in black, and its temperature in red, figures. For a new experiment the levels are adjusted as before.

At a recent meeting of the British Association, at Bradford, Professor G. Carey Foster, F.R.S., presented to the Chemical Science Section the report of the Committee appointed by the Association to examine and report upon the merits of the pyrometer; and the report stated that the first step was evidently to test the electrical permanence of the pyrometer, and the attention of the committee has as yet been confined to the examination of this point. At the Brighton Meeting in 1872, it was reported by them that a pyrometer whose resistance was, to begin with, 9·917 B. A. units at 10° C., had a resistance of 10·502 at the same temperature, after having been repeatedly heated to redness. This change was found by Professor Williamson to be, in all probability, due to chemical alteration of



the platinum caused by the combined action of the silica of the porcelain core on which the wire was coiled and of the reducing atmosphere existing inside the protecting wrought-iron tube. The committee have, since then, been supplied with two new pyrometers, in which, with the hope of preventing the alteration previously found, a platinum tube has been introduced, surrounding the coil and separating it from the outer iron case. The resistance of one of the pyrometers was at first 9·920 at 10°, and, after being twice heated to redness, 10·462 at the same temperature; the other had, to begin with, the resistance 9·988 at 10°, and after one heating its resistance was 10·465 at the same temperature. It is, however, quite possible that little or no further change would be found to occur after the first few heatings, but the committee have been unable during the past year to make sufficiently numerous experiments to enable them to form an optnion on this point. They therefore ask to be reappointed, and for a renewal of the unexpended grant of £30 which was originally placed at their disposal.

REPORT BY M. DELARGE ON THE SYSTEM OF PNEUMATIC TUBES EMPLOYED IN ENGLAND.

THE use of the pneumatic tube has, for the transport of telegraphic dispatches to short distances, become an integral portion of the telegraphic system. Telegraphy is so urgent in its demands, that a telegraphist is compelled to possess knowledge of other sciences than his own. It is, then, with great pleasure that we reproduce the report by M. Delarge upon our pneumatic system. Such a report, coming from a foreign source, is extremely valuable; and, notwithstanding the reports already published by our own eminent engineers, the report by M. Delarge has an intrinsic original value. The source whence we take the report is our excellent French contemporary, the official *Journal Telegraphique*. Prefaced to the report are some historical notes, indicating the progress of this branch of pneumatic science.

The first trials that were made to transport travellers or parcels by means of atmospheric pressure were undertaken at rather an early period. In 1810, the Danish engineer, Medhurst,* proposed to transmit merchandise and post-packets through a tube by atmospheric pressure.

Later, Vallance, an English engineer, undertook to transport passengers and merchandise between London and Brighton in cast-iron tubes by means of rarefied air. A trial was made with wooden tubes six feet in diameter.

Medhurst subsequently modified the arrangement he had at first adopted; he intended that a piston should work in a tube of small diameter, the piston being mounted at a superior point of its periphery by an arm, which was attached (through a hydraulic valve extending the length of the tube, and the tube being laid by the rails the whole distance of communication) to a carriage running on rails. The disadvantage was the action of frost upon the hydraulic valve.

In 1834, Pinkus, an American engineer, took out a patent in London for a longitudinal valve, but this attempt and others that Pinkus made were not successful.

In 1838, Clegg and Samuda, English engineers, contrived a leathern valve which acted with sufficient regularity to enable them to put into practice transport by pressure of air. Their system was tried later in France, but was first applied to a length (of 3 kilometres) between Kingstown and Dalkey, as prolonging the railroad from Dublin to Kingstown. It was subsequently adopted between London and Croydon, and between Exeter and Newton. Finally, with some modifications, it was introduced into France on the railroad between Nanterre and St. Germain. Numerous practical considerations, upon which it is needless to dwell, led, after 14 years' trial, to the abandonment of this method.

After Clegg and Samuda several engineers sought, but without success, to perfect the longitudinal valve. We may mention Hallette d'Arras, Hediard and Arnollet, Talbot, Zambaux, Mallat and Crelle.

In 1846, Clark and Varley adopted an arrangement analogous to that of Clegg and Samuda, but the tubes, split at the upper part, were of wrought-iron. A trial was made for a short time at Poplar, on the London and Blackwall Railway. The friction of the piston is said to have been slight, and the result advantageous, but nothing was done upon a large scale.

As to the transmission of despatches by pressure of air, the first experiment was made, according to the Abbé Moigno, by Ador, in 1852, at the park of Monceau. In 1854, Galy Cazelat in France, and Clark in England, took out a patent for a system of transmission of parcels and letters in tin tubes. Clark established at the same time, at the central station in Telegraph Street, some short tubes worked in two directions by means of a vacuum.

In 1863, Varley completed this installation in utilising compressed air for transmission in one direction, and rarefied air for transmission in the other. He also introduced a system of valves to be described later.

Finally, in 1865, Siemens and Halske established at Berlin, between the Telegraph Office and the Bourse, pneumatic tubes of peculiar arrangement. Two tubes were laid side by side, and connected at one of their extremities to form a complete circuit; the free extremities opening in the telegraph office were put into connection with two reservoirs, one of compressed air, the other of rarefied air, fed by an uninterrupted double action piston put in motion by a steam-engine. In this manner a current of air continually traversed the tubes in the same direction, each serving to transport in one direction. This circuit was 1866 metres in length; but, since 1865, a second circuit of 3750 metres has been constructed between the central telegraph station, Potsdam-Thor and Brandebourg-Thor. This system, modified in detail, was employed in London in 1870.

The pneumatic systems of Mr. Clark, modified by Mr. Varley, and those of Messrs. Siemens, must receive a more detailed description. These apparatus, with the pneumatic tubes at Berlin and those at Paris, are the sole means of transport by compressed air actually in service.

In Paris the pneumatic tubes have been in use since 1867. The apparatus set up in the office

* For details, see "Traité Elementaire des Chemins de Fer," by A. Perdonnet, and the "Handbuch für Spezielle Eisenbahn-Technik," by Edmond Heusinger von Waldegg.

of the Rue Boissy-d'Anglais consisted of three sheet-iron tanks, one of which, of 7 cubic metres capacity, is filled with water, and two (of 5·900 m^3) with air. Communication being established at will between these three tanks and the tube by which the despatches are forwarded attached, a pressure of 1·6 could be attained. The compressed air sent the carriers in one direction; movement in the contrary direction could be effected by allowing the water to flow out from the tank. This system was very simple, but it could be applied only where the quantity of water was sufficient.

Before we examine the London pneumatic tubes, we will complete the preceding historical notes by the mention of trials made to the end of transporting passengers or parcels.

After the establishment of his pneumatic tubes, that is to say, in 1859, Mr. Latimer Clark formed, with the English engineer, Rammel, a company (the Pneumatic Despatch Company), whose aim was to apply atmospheric pressure to transports of every nature. They constructed in London, in 1863, an atmospheric railway (about 550 metres in length), connecting Euston Station and the North Western District Office. The bags and packets of letters were carried by these tubes. The tubes were of cast-iron, Ω-shaped, the vertical axis being 0·84 metre, and the horizontal axis 0·76 metre. The tubes were about 2·75 metres in length; they were cemented at the joints with lead. They formed two curves of 33 metres radius, and one of 12·16 metres. The slope of the line varied from 1 in 80 to 1 in 100. A carriage with four wheels (2·40 metres in length) ran on rails. The motor was a ventilator of 6·38 metres diameter, put in action by a steam-engine. The ventilator made 100 to 100 revolutions per minute; the pressure was $\frac{1}{20}$ to $\frac{1}{10}$ of an atmosphere, representing a force upon the piston of 46 to 62 kilogrammes. The speed was 8·3 metres per second. In 1863, 15 trips were made per diem, at a cost of 0·5 franc per double trip. The use of this line was abandoned on Oct. 26th, 1866. The conditions under which it worked were disadvantageous. The traffic being but small, the larger proportion of fuel was burnt while the engine was at rest.*

In 1864, Rammel established at the Crystal Palace, Sydenham, an atmospheric railway, 547 metres in length, carrying passengers. The arrangement was similar to the preceding. The tube was of brick; 3 metres in height by 2·13 metres in width. The carriages were furnished with paddings of silk, opposing the passage of air by friction against the sides of the tunnel. The carriages contained 30 to 35 persons. The journey was made in 50 seconds, with a pressure of $\frac{1}{10}$ atmosphere. The ventilator was 6·38 metres in diameter. An accident happened, and the experiment was discontinued.

In 1865, the Whitehall and Waterloo Railway Company was formed to connect by an atmospheric line Waterloo and Charing Cross Stations, and the East London Railway Company was promoted to connect pneumatically different lines of railway, the pneumatic tubes being intended to pass through Thames Tunnel.

* Since the date of the reporter's visit to London, this line has been extended to the General Post Office, with an intermediate station at Holborn, and the traffic has been found sufficient for most advantageous use.

In Italy, two projects were proposed by Messrs. Edwards and Dargremont, but they did not meet the approval of the Commission. Finally may be mentioned that in America Mr. John H. Ward proposed a similar line to that of Rammel. It is sufficient to say that, in spite of the numerous failures, the problem of the pneumatic transport of passengers and parcels is still to be solved. But that, on the contrary, the transmission of telegrams by these tubes has given excellent results in towns of the first importance.

(To be continued).

PRACTICAL ELECTRO-PLATING.

We commence under this title a series of articles on the art and practice of Electro-plating. It is not intended that the articles shall follow any prescribed order; for it is considered that to present either improvements or known details of the subject as they may occur, and not to wait until the improvements have become nearly obsolete, so that a certain arbitrary order may be followed, will be the plan likely to render these articles more widely acceptable—that is to say, these articles are intended to be both a guide to developed processes and a record of what is being discovered in the art. To further this aim, the articles will be sometimes original, but necessarily more often an account of what has been done abroad or at home by others. New formulæ, tested by practical work, will be given; the formulæ obtained from other sources will be tested where the authority is not stated; and, indeed, every care will be taken to render these columns of *practical* worth to the electro-plater. The papers will be revised, and in some part written by a practical plater, sometime engaged in the works of Messrs. Christofle and Co., Paris.

To carry out the intended principle of recording present statements by others, we present to our readers the remarks on

Nickel Plating,

communicated to the "Franklin Institute," by Dr. Lewis Feuchtwanger. He says:—An important branch of industry has been in practice in the United States for the last few years only, although it was recommended by Alfred Smee, F.R.S., in his "Elements of Electro-Metallurgy," in 1852, who, in page 193, speaks of nickel in the following words:—

"Nickel is the last in the list of noble metals, being the most ignoble of that class. The nitrate and sulphate of nickel, the ammonio-nitrate and sulphate of nickel, the nikelo-cyanide of potassium, but especially the chloride of nickel, require consideration. The nitrate of nickel is very soluble, but the metal has no great inclination to be precipitated, for the hydrogen appears rather to prefer being evolved than to reduce the metal. The sulphate of nickel is also used as a double salt, and the metal is reduced more readily from it than from the nitrate. It is best reduced by the compound battery process with a platinum positive pole, though a nickel positive pole may be employed. The solution of either nitrate or sulphate combined with alkalies, those of ammonia deserving the preference, ought to be as strong as possible. The chloride of nickel forms an excellent material for

precipitation, by means of a nickel positive pole with one or two batteries. The nickel so deposited has a peculiar white, brilliant lustre, looking almost like glass. This deposit is so beautiful, when removed from the negative pole, that it forms a great contrast to the common nickel metal, and no person would ever suppose that there was any similarity of composition between that substance, still less identity. For practical purposes the chloride is first, and next to it is the sulphate for the reguline deposit."

It has been ascertained that the nickel-plated ware lasts four times as long as the silver-plated, and is four times cheaper than silver-plating, nor does it tarnish as easily as silver; for sulphuretted hydrogen acts readily on silver, and not on nickel. We see now everywhere the utensils for the house, ship, harness and carriage trimmings, dental, surgical, philosophical and musical instruments, reflectors, stair-rods, guns and pistols, many models requiring protection from the oxidising or corroding action of the air or water, with a vast number of articles in daily use, as also the polished iron and brass materials used on board of a ship, where the salt water atmosphere is so liable to corrode, and machinery of every description plated with nickel. There was a capstan so plated, at the late fair of the American Institute, which the writer conceived to be injudicious, for the reason that nickel is magnetic, and should not be employed near the compass. The batteries used in the nickel-plating are of various inventors, such as the Wollaston, Daniell, Grove, Bunsen, and Smee batteries.

Daniell's battery consists of a box of eight inches to two feet in height, and four inches in diameter. The outer vessel is to be made of copper, of which the external part may be painted, as it plays no part in generating electricity, while the inner remains uncoated. Into this cylinder a solution of sulphate of copper is to be poured, instead of the dilute acid used in other batteries. In order to separate the zinc cylinder from the sulphate of copper, it rests in a porous cup, which contains the zinc surrounded by dilute sulphuric acid. As soon as contact is made the zinc is dissolved, and sulphate of zinc is retained in the inner part of the vessel; whilst, instead of the hydrogen being evolved at the negative metal, it reduces the copper from the sulphate of copper. The more porous the inner vessel is, the greater is the quantity of electricity developed; therefore coarse canvas or porous earthen tubes are now employed instead of the bladder. Daniell used for his positive metal cast zinc rods, which he amalgamated. But zinc cylinders are indispensable, and the porous vessel must not touch the battery plates. This battery has the power of generating exactly the same amount of electricity for a long time, and is celebrated for its effects.

Grove's battery employs platinum as the negative metal, and has in the inner porous cells strong nitric acid, while the outer cell of the zinc cylinder contains dilute sulphuric or muriatic acid; the nitric acid, when employed, is decomposed by the hydrogen, and deutoxide of nitrogen is evolved, which is converted into nitrous acid when coming into contact with atmospheric air.

This battery is remarkable for its intensity. Four such single batteries are sufficient for large operations in electro-plating. The only drawback to its genera uses is the nitrous acid fumes, which are very offensive; the same fumes also attack the zinc to a considerable extent. While Grove's battery has its good side, it has also the disadvantage of varying the quantity of electricity by altering the wires as to size and length, as also the labour to set a Daniell's battery in motion; also the trouble and expense in using the porous tubes, and the necessity of continually re-amalgamating the plates.

In Grove's battery the nitrous acid fumes of the nitric acid battery which are so objectionable have been changed in the application of bichromate of potash, which, in a concentrated state of solution, is put on the negative side of the battery, while dilute sulphuric acid is used on the zinc sides. This latter is dissolved on the outer side of the battery by dilute sulphuric acid, and the bichromate is decomposed at the negative end.

Smee's Chemico-Mechanical Battery.—A small quantity of nitro-muriate of platinum is thrown down on the sheet-platinum, previously roughed by sand-paper. The same process may be performed on palladium, silver (roughened by nitric acid), plated copper, iron of every sort, and on charcoal—all with the same good result.

Silver is most generally employed on account of its cheapness, and not undergoing any alteration. The object is to afford a surface to which the hydrogen shall not adhere, but shall be evolved from it. The platinised silver used for this purpose ought to be thick enough to carry the current of electricity, and should be roughened either by sand-paper or by brushing it over with a little strong nitric acid, so that a frosted appearance is obtained. The silver is then washed and placed in a vessel with dilute sulphuric acid, to which a few drops of nitromuriate of platinum are added; a porous cup is then placed in this vessel, with a few drops of diluted sulphuric acid; into this the zinc is put. Contact being made, the platinum will in a few seconds be thrown down upon the surface of the silver, as a black metallic powder. The operation is now completed, and the platinised metal ready for use.

Iron, if prepared in the same manner as silver, may be used for the same purpose, and employed with advantage; all that is required is to rub a little nitromuriate of platinum over it, and an immediate deposit of the black powder takes place. The liquid generally adopted to excite this battery is a mixture of 1 part by measure of sulphuric acid and 7 of water, which will be found amply strong for all purposes. Where we desire greater intensity, it can be obtained by the addition of a few drops of nitric acid, but if too much be used, it might attack the silver. The operator will frequently find it advisable to use diluted sulphuric acid, only retaining 1-10th to 1-16 of the pure acid, and adding some acid when the first is exhausted. The zinc, acid, and water being severally required to excite the battery, they may be regulated so that they should all be exhausted at once, so that the zinc should neutralise the acid and the resulting sulphate of zinc exactly saturate the water.

In place of platinised silver, carbon plates have been used with decided success for the negative poles.

From what has been stated, it is obvious that Daniell's battery is distinguished for its constancy,

Grove's for its intensity, and Smee's for cheapness and simplicity in the development of electricity. It is of great importance to know which battery yields the greatest amount of galvanic fluid at the smallest cost, least labour and greatest convenience. The main tendency of the three described batteries lies in the action of zinc upon water, and when, in connection with acid, to form sulphate of zinc.

Bunsen's battery depends upon the application of carbon cylinders, and forms also a convenient and economical apparatus.

The platinised silver plates of Smee's battery are now replaced by carbon plates, as also by chrome plates which are said to form a very constant battery; while offering a greater surface for the decomposition of the metallic salt, they must prove more economical.

In our next we will consider the "Coating with Nickel."

(To be continued).

THE AMERICAN DISTRICT TELEGRAPH COMPANY.

At the last meeting of the *Franklin Institute* there was described, and exhibited in operation, a system of telegraphing now about being introduced into Philadelphia, which, from its very great convenience, bids fair to become a decided favourite amongst business men, as well as to serve many useful purposes in the household. The Hon. Daniel M. Fox, ex-Mayor of Philadelphia, introduced the subject to the attention of the members of the Institute, giving briefly a history of the gradual extension of the art of telegraphy to constantly increasing usefulness, and then explained the district system of telegraphy as follows:—

"This small iron box (showing it) contains a simple train of clock-work, which, when released and allowed to run, causes a small wheel, called a circuit-wheel, to revolve, and when connected by wires with a battery and suitable apparatus, breaks and closes the electrical circuit a certain number of times, regulated by teeth cut in the wheel, thus indicating a certain fixed number. The wheels being different in numbers of teeth or notches, of course different numbers are communicated, and you readily see how invaluable this little box becomes. As utilised by the American District Telegraph, the calls are given for a messenger, a police officer, or the Fire Department. To explain more fully, the city is laid out into districts of about sixteen squares each. Near the centre of each district is located an office, from which wires radiate and are conducted to all parts of the district, running in and out of dwelling-houses, public buildings, stores, offices, factories, &c. The signal-boxes are connected with these wires, and in the district office the wires are connected with galvanic batteries, call-bells, and self-starting Morse registers. The instant one of these boxes is operated upon, by merely pulling the ring projecting beneath, the circuit-wheel is allowed to revolve once, and its number is rung upon the call-bell, and recorded upon the strip of paper set in motion by the self-starting Morse register in the district office. The operator at once dispatches a messenger boy to answer the call. If the ring is pulled three times it indicates that an officer is wanted, and one is sent at once, accompanied by a messenger; if the ring is pulled more than three times in succession, fire is indicated, and the officer answers the summons with a fire-extinguisher, and the alarm is instantly communicated to the central office of the City Police and Fire Alarm Telegraph, and also the several fire-engine and hose houses. Thus it will be seen that electricity is to be reduced from its proud position as a messenger between continents to the humble uses of domestic life. It is to be made an errand-boy, to answer every household call. There are thousands of little services which persons in moderate circumstances would gladly pay for at the rates charged by the Company, who cannot afford or do not desire to keep an errand-boy or male house-servant. The American District Telegraph Company proposes to perform the messenger service indispensable among business men in a manner so thorough, expeditious, and cheap, that the most entire satisfaction shall be given subscribers. A lawyer, banker, or broker, desiring to communicate with his client, or customer, touches the telegraphic key, and instantly summons a trusty and swift-footed messenger. A client at the office of his solicitor or financial agent requires the services of a reliable person, to bring or to carry valuable papers, or to perform any one of the thousand services which in a great city are in constant requisition. The telegraph places at his command, and at moderate charge, the trained servants of a responsible corporation whose interest it is that its patrons should be promptly and faithfully served. A tradesman wishes to forward to his customer any article furnished; the telegraph permits him to do so. Hotel-keepers find that it not only saves an extra errand-boy, but is also a great convenience to their guests. A special feature of this system is to protect against burglary or fire. If a housekeeper is disturbed in the night by a noise of burglars in his house, he merely pulls the ring, and one or more policemen will arrive before the burglars have time to effect an entrance. If your house is left vacant during the season, burglar attachments can be made with the instrument, and everything so arranged that the opening of a door or window is made known at once at the district office. A fire is discovered in the house; the alarm is at once given by pulling the ring as directed, and almost as soon as a bucket of water can be obtained in the house, men appear at the door armed with fire-extinguishers, accompanied by messengers, and in many cases will have extinguished the fire before the arrival of the fire department, which has also been summoned by the same agency. In fact there is no end to the use and convenience of our universal friend."

At the conclusion of Mr. Fox's remarks, a practical exhibition of the District Telegraph system was given, to the great interest of the members. Batteries and alarm-boxes, with wires connected with the District Office at Seventh and Chestnut Streets, were put in the lecture-room. A signal was sounded for a messenger, and in about one minute a lad, dressed in uniform, rushed into the room with paper and pencil in hand, ready to deliver any message. A signal was then given for an officer, and also in a minute a conservator of the peace was in the midst of the audience, ready for duty. A fire alarm was then given, and in one minute's time appeared a man with a fire-annihilator

strapped on his back, ready to go into service. These parties all came from the District Office at Seventh and Chestnut Streets, and did not leave there until they were summoned by the alarm-box, operated on by the speaker.

TABLES TO FACILITATE THE CALCULATION OF STRAINS OF SUSPENDED (IRON OR STEEL) WIRES.

(FOR THE USE OF LINEMEN).

By ROBERT SABINE, C.E.

(Continued from p. 284.)

TABLE II.—STRUTS AND STAYS.

Col. 1. Distance between strut or stay and post at 10 feet down. ft.	in.	Col. 2. Proportional strain in strut or stay.
2	0	5·02
2	3	4·47
2	6	4·03
2	9	3·67
3	0	3·37
3	3	3·12
3	6	2·90
3	9	2·71
4	0	2·55
4	3	2·41
4	6	2·28
4	9	2·17
5	0	2·07
5	6	1·89
6	0	1·75
6	6	1·63
7	0	1·53
7	6	1·44
8	0	1·36
8	6	1·30
9	0	1·24
9	6	1·20
10	0	1·16

VIII. *To find the actual* {*stress* / *strain*} *on a given* {*strut* / *stay*} *placed in the proper direction.*

Rule 1.—Mark out, by the method given n Rule VI., the proper line of direction, and measure the distance, *m o*, in feet. The horizontal strain on the post in the direction, *m n*, may be taken as equal to the actual strain on A in lbs., multiplied by twice *m o* in feet, and divided by *o a* in feet.

2.—Next measure downwards, and mark from the point where the {strut / stay} joins the post a length of 10 feet on each; and with a tape measure the distance across in feet, between the two marks.

3.—Find in Table II. (col. 1) the nearest value to this distance, and with the corresponding number in col. 2 multiply the horizontal strain found (by 1) above. The product is the actual strain on the {strut / stay} in lbs.

Example.—The post in the Example given with Rule VI. is provided with a stay in the line, *m o*. The length of the line, *m o*, by measurement I find to be equal to 6 feet. The horizontal strain in the post is, therefore, 720 lbs.; because—

$$10' : 600 :: 2 \times 6' : 720.$$

I mark off from the point (*a*) 10 feet to *b* on the post, and to *c* on the stay, and measure the distance across from *b* to *c*, which I find to be 4ft. 3in. Lastly, I refer to Table II., and opposite 4ft. 3in. I find (in col. 2) the figures 2·41. The strain on this stay is, therefore—

$$2{\cdot}41 \times 720 = 1735 \text{ lbs.}$$

In this rule it is assumed that the strut or stay touches the post at the same height as the mean strain acts horizontally.

If, however, the strain at *a* is higher or lower than the top of the strut or stay, the result found by the last rule must be multiplied by the height of the strain, and divided by the height of the top of the

FIG. 2.

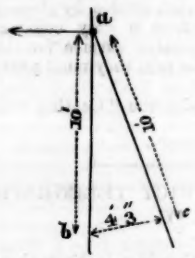


FIG. 3.

strut or stay, both heights being measured on the pole.

Example.—Suppose in the last example the mean strain acts at *a*, at 20 feet from the ground, but that the stay reaches only *a'* 15 feet up, then the actual strain will be—

$$\frac{1735 \times 20}{15} = 2313 \text{ lbs.}$$

IX. *The resultant horizontal strain of the wires in the proper direction of a stay or strut, and the maximum strain which the stay or strut is to bear, being given, to find the angle at which it must be placed against the post.*

Rule 1.—Find, by Rule VIII. (1), the horizontal strain in lbs. acting in the proper direction of the {strut / stay}.

2.—Divide the given maximum strain in lbs. by the horizontal strain in lbs., and find in Table II. (col. 2) the nearest value to the quotient. Col. 1 gives the distance which the {strut / stay} must stand from the post, at a point measured 10 feet down.

Example.—Suppose the horizontal strain calculated by Rule VIII. (1), to be, as in the last example, equal to 720 lbs., and that a stay is to be employed which must not bear more than 1500 lbs.—

$$\frac{1500}{720} = 2{\cdot}08.$$

In col. 2, Table II., the nearest value to 2·08 is 2·07, opposite to which, in col. 1, is given the distance (5 ft.) which the 10 ft. marks must stand apart.

In dealing with overhead telegraph wires, the actual strain may be taken as the horizontal strain, because they are generally allowed so little sag.

THE liability of safety valves to stick, in consequence of corrosion, is obviated by nickel-plating both the valve and the seat.

THE steamship *Hooper* has arrived off Dover from Para, after having successfully laid the cable of the Western and Brazilian Telegraph Company from Pernambuco to that port. She will leave again at the end of the month for the purpose of submerging the sections of cable from Pernambuco to Bahia and from Bahia to Rio de Janeiro.

MATHEMATICS FOR NON-MATHEMATICIANS.

By W. PAGET HIGGS, LL.D., D.Sc.

Division I.—The Algebra of Constant Quantities.

(Continued from p. 281.)

Division, Fractions, and Ratio.

The reader may ask why the common order of mathematical books is departed from, by bringing to one focus the consideration of the principles of so apparently diverse subjects as division, fractions, and ratio. Perhaps the most efficient answer will be found in a general statement of the symbols employed in the algebraic representation of these processes.

I. The operation of *division* is, algebraically, represented in two ways:—

a. The quantity to be divided (the *dividend*) is written before the sign ÷ (to be read "divided by"), and this sign precedes the dividing quantity (the *divisor*). Thus $a \div b$ is to be understood to indicate the division of a by b.

b. The dividend is written above a short line, the divisor below the line, thus $\frac{a}{b}$.

In both cases the result of division is termed the *quotient*. And the entire operation and result may be stated in the form of an equation, either as—

(*a*). $a \div b = q$; or as—

(*b*). $\frac{a}{b} = q$.

II. The last expression, $\frac{a}{b}$, is the general form by which is represented a *fraction*; illustrated by supposing a to represent an apple, and b the number of parts into which it is to be divided. If we divide one apple in two parts we have, numerically, $\frac{1}{2}$ or one-half as the result. And generally if we divide n things into p portions, or among p persons, each portion will be, or each person will get, that quantity of the things represented by $\frac{n}{p}$.

III. There are two methods of representing the relation or *ratio* of two quantities:—

(*a*). The most useful is in the form of a fraction, as $\frac{n}{p}$; here the ratio expressed is that of the number of things to the number of persons.

(*b*). The other method of representing the ratio two quantities bear to each other is by placing between them a colon (:),—thus $n : p$ has the same meaning as $\frac{n}{p}$, both expressions indicating the relation of the quantities.

Proportion is the equality of ratios. It is a common error to say that "two numbers bear a certain *proportion*;" correct mathematical language would dictate that "two numbers bear a certain *ratio*." Only *two ratios* can be said to be *proportionate*. Thus, if we have to divide a apples amongst b boys, or algebraically $\frac{a}{b}$; and if we have to divide n things amongst p persons, or algebraically $\frac{n}{p}$; then if the two ratios $\frac{a}{b}$ (ratio of the number of apples to the number of boys) and $\frac{n}{p}$ (ratio of number of things to number of persons) be equal, we may place between them the sign of equality (=) and the equation expresses a proportion—

$$\frac{a}{b} = \frac{n}{p}$$

or—

$$a : b = n : p;$$

or, again, substituting the sign :: for the sign of equality—

$$a : b :: n : p.$$

This we see is a return to an earlier arithmetical stage of a rule-of three sum. For suppose 6 apples amongst 3 boys and 4 things amongst 2 persons, we have—

$$6 : 3 :: 4 : 2.$$

The relation, therefore, of division, fractions, and ratio is sufficiently close to call for their undivided consideration. The expression—

$$\frac{a}{b}$$

may, we have seen, mean—

I. The number of times a contains b.

II. A fraction, a being the *numerator* and b the *denominator*.

III. The relation or ratio of a and b.

These three heads really express, under different forms, the same notion—the relation of a to b. In each case we may determine the value of the relation by a process of continued subtraction (as in multiplication we arrived at the product by a process of continued addition). Suppose, as a first example, that a represents 10, and the numerical value of b is 2; we shall find the value of the relation of a to b or $\frac{a}{b}$ to be 5; for we can subtract 2 from 10 5 times.*

10		
2	1st subtraction.	
8		
2	2nd	„
6		
2	3rd	„
4		
2	4th	„
2		
2	5th	„
0		

Suppose, as a second instance, that a should represent 2 and $b = 10$; then we should know that we have to divide 2 in 10 parts or 1 into 5 parts, taking one of those parts, or $\frac{1}{5}$th.

* Had 11 been taken for a there would have been a remainder (*r*) =1, and the general algebraic expression would become (where *q* represents the quotient)—

$$\frac{a}{b} = q + r.$$

Let us now study the effect of different algebraic arrangements of the general expression—

$$\frac{a}{b}=q, \text{ or } \frac{10}{2}=5.$$

In words, this tells us that the result of dividing the dividend (a) by the divisor (b) is the quotient (q). Again—

$$a=qb, \text{ or } 10=5\times 2,$$

or the dividend equals the quotient multiplied by the divisor. And—

$$b=\frac{a}{q}, \text{ or } 2=\frac{10}{5},$$

or, the divisor equals the dividend divided by the quotient.

Besides these equations, there are others expressing fundamental principles, and the chief of these is—

$$\frac{na}{nb}=\frac{a}{b},$$

or the multiplication of the numerator and denominator of a fraction, or the multiplication of the dividend and divisor, by an equal quantity, does not affect the value of the fraction nor of the quotient. Whence it may be perceived—

That the multiplication of the numerator of a fraction by an integer increases the value of the fraction.

That the multiplication of a dividend by an integral quantity increases the value of the quotient.

That conversely the multiplication of a denominator by an integral quantity decreases the value of a fraction.

That the multiplication of a divisor by an integral quantity decreases the value of the quotient.

If we substitute for the term "integral quantity" or "integer" (Anglicé, *whole* number) a fractional quantity, of course the converse only of each rule will hold good.

Rules for Division.

If we observe the rule (the same as for multiplication) that *division of* LIKE *signs yields a* POSITIVE *quotient, of* UNLIKE *signs a* NEGATIVE *quotient*, we may reduce the numerous rules for division given in many of our text-books to the following:—

(1). To divide one *monomial* by another,—suppress the letters that are common to both; subtract the exponents which affect the same letters; and divide the coefficients one by another.

(2). To divide a *polynomial* by a *monomial*,—divide each term of the polynomial by the monomial according to the first rule; connect the results by their proper signs (remembering like produce positive, unlike produce negative, signs).

(3). To divide *two polynomials* one by the other,—arrange them with respect to the same letter; then divide the first terms one by the other, and thence will result one term of the quotient; multiply the divisor by this, and subtract the product from the dividend: proceed to the end in the same manner.

(4). To divide algebraic fractions,—invert the terms of the divisor, and multiply together the numerators and the denominators.

*Examples to these Rules.**

(1). $$\frac{12a^2b^2c}{3ab}=\frac{12}{3}a^{2-1}b^{2-1}c=4a^1bc.$$

(2). $$\frac{6a^2+12ab-9abc}{3a}=\frac{6a^2}{3a}+\frac{12ab}{3a}-\frac{9abc}{3a}=$$
$$=2a+4b-3bc.$$

(3). $$\frac{a^3-3a^2b+3ab^2-b^3}{a-b}.$$

Divisor. Dividend. Quotient.

$$a-b)a^3-3a^2b+3ab^2-b^3(a^2-2ab+b^2$$
$$a^3-a^2b$$
$$-2a^2b+3ab^2$$
$$-2a^2b+2ab^2$$
$$ab^2-b^3$$
$$ab^2-b^3$$

Students' Column.

Earth Electricity. By Robert Sabine, C.E.

The average electrical potential surrounding objects in contact with the earth's surface appears to us to be of course *zero;* those bodies which are in the electrical state of a rubbed glass we call positively electrical, and they are said to be at a higher potential than the earth; those bodies, on the other hand, which are in the electric state of the cloth with which the glass is rubbed, we call negatively electrical, and they are said to be at a lower potential than the earth.

In just the same way we say of a body which has a higher temperature than the hand we lay upon it, that it is warm, and of a body of a lower temperature than the hand, that it is cold; the electrical conditions, positive and negative, and the heat conditions, warm and cold, being relative only, one to the electrical state of the earth and objects in contact with it, the other to the caloric state of the hand by which differences of temperature become sensible to us. But there is no greater difference between "positive" and "negative" electricity than between heat and cold. In dealing with heat we are able to imagine an absolute zero-point, and to determine its possible position with tolerable accuracy; but there exists most probably in nature no point of absolute zero, either of heat or of electrical potential; that is to say, that no matter of whatever kind in the universe is without heat and an electrical charge of some value or other. The possible place of an absolute zero-point of electric potential has not been attempted to be determined; because the behaviour of bodies charged to various degrees has been so little observed that no idea has been formed of when or how a body might be imagined to be without any electricity at all.

If we regard the surface of the earth as having a certain average electrical potential, most, if not all, the phenomena of atmospheric electricity and terrestrial magnetism become more or less explicable, as has already been pointed out. Thus the electrified surface of the earth would act through the insulating medium of its surrounding atmosphere upon the highly conducting irregular shell of upper rarefied air, and hold in it a charge of induced electricity, which would probably not go beyond the limits of the atmosphere, because, beyond a certain point, the

* As it is not wished to explain principles that should be evident to the student, we refrain from comment on these rules, believing that numerical substitution will readily give the why and wherefore.

nearer the rarefaction approaches to a vacuum the worse becomes the conduction of the gas. This tension between the earth and induced charge of its upper atmosphere would account for the various electrical states of the clouds and lower atmosphere, by the known phenomenon of electrification of dielectrics by which electricity appears to creep in and out according to the relative states of the surface conductors, and would in this case be assisted greatly no doubt by the mobility of the insulating medium. Another phenomenon which might be accounted for by the same hypothesis is that of the polar lights, regarding them as resulting from the recombination of the electricities of the opposite sides of the great supposed terrestrial Leyden jar, under favourable conditions through the medium of its air-dielectric. Lastly, in this supposition the phenomenon of terrestrial magnetism might also find an explanation. For in those altitudes where the rarefaction is so great that the repulsion between the gaseous atoms balances their terrestrial gravitation, they probably do not follow the earth in its diurnal rotation, and if this irregular upper shell is charged by induction negatively, and remains still whilst the earth rotates underneath it, the result would be the same as if the earth remained still, and the charged shell rotated over it. Either would be equivalent to a negative current circulating around the earth in the direction of the sun's apparent motion, which would convert the earth into a huge electro-magnet, with poles placed exactly as we find them. Now I want to call attention to the fact that this hypothesis of an induced electrical state of the upper rarefied air, would involve the assumption of extraneous normal electrical conditions, capable of determining the difference between the potentials of the upper air and of the earth. For, as the earth's potential is always a mean between the potentials of the two coatings of a charged Leyden jar upon its surface, it is evident that the potential of something still greater must be the mean between those of the earth's surface and of its upper air, if these themselves enter into a Leyden combination.

Such a state of things would be represented by the diagram below:—

$$\left.\begin{matrix}\text{Negative electricity}\\ \text{Positive electricity}\end{matrix}\right\}\ \frac{\text{Potential of upper air}}{\text{Potential of earth}}\ \Big\}\ \text{Potential of space.}$$

The first column would represent the state of a Leyden jar charged with positive and negative electricity, whose mean would express the potential of the earth. This in turn would form the positive side of the second Leyden jar with the upper air as its negative side. And the potential of space must be in the same way a mean of these two.

In this diagram I have represented the earth as positive to the air, and therefore also as positive to sun, or space, whichever may be the determining agent. There are two reasons which induce me to do so. First, the magnetic action of an irregular negatively charged shell at rest in regard to the earth's diurnal rotation, agrees with the positions of the earth's magnetic poles; secondly, when a series of three kites was raised in the air upon the same string, we are told* that the highest kite was almost invariably positive to the other two, the centre kite positive to the one below it, and the lowermost positive to the ground. This is precisely what would occur by induction of the positive earth and negative upper air; the highest kite nearest to the negative upper air would be charged by induction positively, the lowest being nearer to the positive earth would have a negative charge induced in it, whilst the middle one would take a mean potential between the other two. Or we can regard these charges as the three negative charges induced by the positive earth, the highest and most distant kite being weakest negatively, and therefore positive to those below it.

* Noad's "Student's Text-Book on Electricity," 1867, p. 81.

PAPERS FOR JUNIOR STUDENTS.

Induction.

We will not attempt to define what is meant electrically by the term induction; the student shall first study some of the effects known as inductive effects or phenomena. To define induction it would be necessary to revert to one or other of the theories proposed for the explanation of electrical phenomena, and in these papers it is wished to avoid theoretical discussion, and to confine as much as possible the attention of the student to the observation of facts.

The phenomena of induction are classed under two heads:—

A. Static.

B. Dynamic, or current induction.

Those of dynamic induction may be subdivided into—

a. Electro-magnetic.

b. Magneto-electric.

The head that includes phenomena, most nearly related to those with which we are acquainted is that of electro-magnetic induction.

We know that the passage through a wire of an electric current causes the wire to become magnetic. When thus magnetic we know that the wire will influence a magnetic needle in its neighbourhood. Now, if we substitute another wire for the magnetic needle, we shall find that the current in the first wire "induces" or "brings into" the second wire a current in the opposite direction to that in the first wire.

Let us call the first wire the inducing wire; the second wire the induced wire. In strictness, instead of wire, we should say current; but the terms will serve to distinguish the two wires.

The induced wire we will suppose joined at its two ends to the terminals of the ends of the coil of a galvanometer. The galvanometer should be moderately delicate.

The inducing wire is joined at its two ends to the poles of a battery (the only battery in question: remember there is no battery in the circuit of the induced wire).

The wires thus "connected up," we are ready to commence our experiments.

Expt. 1.—We gradually approach the inducing wire to the induced wire, keeping them parallel. As long as the motion of the wires is continued, we notice that the needle of the galvanometer is deflected in one constant direction, say to the right. That immediately we cease to move the inducing wire the needle falls to zero, indicating that the induced current has ceased in the second wire.

Expt. 2.—If we withdraw the inducing wire the needle is deflected to the left (in the opposite direction to that in the first experiment) as long as the movement is continued; but immediately we cease to move the wire the induced current also ceases.

Expt. 3.—Similar effects occur if we allow the inducing wire to remain stationary, and move the induced wire; and if we move both wires at the same time we have similar results.

Expt. 4.—The inducing wire is now to be disconnected from one of the poles of the battery. When the wire is again touched to the pole of the battery, the needle of the galvanometer is suddenly and violently deflected, and then falls to and remains at zero, notwithstanding contact is still maintained between the battery and the inducing wire. When the contact is broken the needle is again deflected, but in an opposite direction.

Expt. 5.—The other pole of the battery produces contrary deflections of the galvanometer needle.

From these experiments we learn that a current is induced in a parallel wire by a current in another wire only when the battery circuit is broken or is completed, or by approximation or removal of the two wires. Thus there must be some condition connecting these phenomena. This condition has been found to be a change in the magnetic condition of the wires. Every wire is, as we know, a magnet while a current is passing in it; and if the current be constant, the magnetism will also be constant. Hence we perceive why the needle fell to zero when we ceased to bring the wires closer together. We then ceased to alter the magnetic condition of the wires; but when we brought the wires closer together, we increased the effect of the magnetism of the inducing wire upon the induced wire. When we gradually removed the inducing wire, we gradually reduced the strength of the magnetic field in which the induced wire was lying.

Again, when the battery contact was made in the later experiment, we suddenly rendered the inducing wire magnetic. When the battery contact was broken, the magnetic field in which the induced wire was lying again suffered a sudden change. Had we suddenly reduced the strength of the battery current without actually breaking contact, the effect would have been similar but less marked.

In our next paper we shall deal with the more definite laws and applications of what we have now observed.

Notes and Queries.

Lightning Recorder.

Is there any plan in use (or known) of making a lightning conductor record whether it has been utilised during a thunderstorm, in averting a disaster from the building it protects? It would be satisfactory to be able to read off the fact, in the morning, after a night of thunder and lightning. Probably some of your readers may direct their attention to the subject.—J. M.

Magnetism of Iron Ships.

Some of our readers have asked for elementary information as to the magnetism of iron ships; we cannot do better than quote from Atkinson's "Ganot's Physics" upon the subject:—"The inductive effect of terrestrial magnetism upon the masses of iron always found in ships exerts a disturbing action upon the compass-needle. This *local attraction*, as it is called, may be so considerable as to render the indications of the needle almost useless, if it be not guarded against. A full account of the manner in which local attraction is produced, and in which it is compensated, is inconsistent with the limits of this book, but the most important points are the following:—(1) A vertical mass of soft iron in the vessel, say in the bows, would become magnetised under the influence of the earth; in the northern hemisphere the lower end would be a north pole, and the upper end a south pole; and as the latter may be assumed to be nearer the north pole of the compass-needle, it would act upon it. So long as the vessel was sailing in the magnetic meridian this would have no effect, but in any other direction the needle would be drawn out of the magnetic meridian; and a little consideration will show that when the ship was at right angles to the magnetic meridian, the effect would be greatest. This *vertical induction* would disappear twice in swinging the ship round, and would be at its maximum twice; hence the deviation due to this cause is known as *semi-circular deviation*. (2) Horizontal masses again, such as deck beams, are also acted upon inductively by the earth's magnetism, and their induced magnetism exerts a disturbing influence upon the magnetic needle. The effect of this horizonal induction will disappear when the ship is in the magnetic meridian, and also when it is at right angles thereto. In positions intermediate to the above, the disturbing influence will attain its maximum. Hence, in swinging a ship round there would be four positions of the ship's head, in which the influence would be at a maximum, and four in which it would be at a minimum. This effect of horizontal induction is accordingly spoken of as *quadrantal deviation*." The remedy for these inductive directions is found in "swinging the ship." This process consists first in comparing the indications of the ship's compass with those of a standard compass on shore. Then the vessel is swung round in various positions, and the directive force of the earth's magnetism upon the compass needle rendered always the same by counteracting the ship's magnetism (induced from the earth) with small vertical and horizontal bars of iron placed near the steering compass. In the Royal Navy the plan adopted with iron ships is in this manner to compensate for or counteract the ship's magnetism to a considerable extent, and then to tabulate the residual errors, so that by reference to the table the possible deviation from the true course may be known.

Proceedings of Societies.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Bradford Meeting, 1873.

A paper "*On Black Deposits of Metals*" was read before the Chemical Section by Dr. Gladstone, F.R.S., and we quote that portion of it interesting to electroplaters. If one metal, it was stated, be thrown down from solution by means of another metal, it does not always present itself of the same colour as it exhibits when in mass; in fact, most metals that are capable of being precipitated by substitution may be obtained in a black condition. The allied metals, platinum, palladium, and iridium, are generally if not always black when thus precipitated, and bismuth and antimony form black fringes and little else. Similar fringes are also formed by gold, but it also yields green, yellow, or lilac metal according to circumstances. Copper, when first precipitated on zinc, whether from a weak or a strong solution, is black; but in the latter case it becomes chocolate-coloured as it advances, or red if the action be more rapid. Lead, in like manner, is always deposited black in the first instance, though the growing crystals soon become of the well-known dull grey. Silver and thallium appear as little bushes of black metal on the decomposing plate, if the solution be very weak; otherwise they grow of their proper colour. Zinc and cadmium give a black coating, quickly passing into grey when their weak solutions are decomposed by magnesium. The general result may be stated thus: If a piece of metal be immersed in the solution of another metal which it can displace, the latter metal immediately makes its appearance at myriads of points in a condition that does not reflect light; but as the most favourably circumstanced crystals grow, they acquire the optical properties of the massive metal, the period at which the change takes place depending partly on the nature of the metal and partly on the rapidity of its growth. In the production of the black deposit of the copper-zinc couple lately employed by the author and Mr. Tribe to break up various compound bodies, there are several stages that may be noticed. At first an out-growth of copper forms on the zinc then, while this action is still

proceeding, the couple itself acts upon the water or the sulphate of zinc in solution, the metallic zinc being oxidised, and hydrogen gas or black zinc being formed against the copper branches. This deposit of zinc was originally observed by Dr. Russell. The arrangement of the particles between the two metals in connection is supposed to be somewhat thus:—

$$Cu \mid ZnSO_4 \mid ZnSO_4 \mid H_2O \mid H_2O \mid Zn$$

which, by the conjoint power and chemical force, becomes—

$$Cu \mid Zn \mid ZnSO_4 \mid H_2SO_4 \mid H_2O \mid Zn$$

If there is still copper sulphate in the solution, this deposited zinc may in its turn become coated with copper, but if it remains exposed to water it is sure to become oxidised. The black deposit often assumes a brownish colour when this is the case. The copper on which zinc has been deposited gives a brassy streak when rubbed in a mortar; but the presence of oxide tends to prevent the sticking together of the detached pieces of metal, and thus the formation of a streak on pressure. If, however, the oxide be removed by acetic acid, the clean ramifications of metal, whether black or otherwise, conglomerate of their own accord in a remarkable way, and little pressure is required to obtain a yellowish metallic streak; while if hydrochloric acid be used, the zinc itself also dissolves with effervescence, and the conglomerating pieces of metal, when rubbed, give a coppery streak.

The total number of persons who attended the Bradford meeting is 1,983, and the total amount received, £2,102.

Section A.—Mathematics and Physics.

The following is a list of the grants of money appropriated to electrical purposes by the General Committee:—

	£	s.	d.
Glaisher, Mr. J.—Efficacy of Lightning Conductors (renewed)	50	0	0
Balfour Stewart, Prof.—Magnetism of Iron	20	0	0
Glaisher, Mr. J.—Luminous Meteors ..	30	0	0
Tait, Prof.—Thermo-Electricity (renewed)	50	0	0
Williamson, Prof. A. W.—Testing Siemens' Pyrometer (renewed)	30	0	0

Section D.—Biology.

"*On the Electrical Phenomena which accompany the Contractions of the leaf of Dionæa muscipula.*" By Dr. BURDON-SANDERSON. It is well known that in those structures in the higher animals which are endowed with the property of contracting when stimulated—viz., nerve and muscle—this property is associated with the existence of voltaic currents which have definite directions in the tissue. These currents have been the subject of very careful observation by physiologists. They require delicate instruments for their investigation, but the phenomena dependent on them admit of the application of the most exact measurements. The constant current which can be shown to exist in a muscle is called the normal current. The most important fact with reference to it is that it exists only so long as the muscle is alive, and that it ceases during the moment that the muscle is thrown into action. Other characteristics of the muscle currents were referred to, which we have not space to mention. In certain plants said to possess the property of irritability, contraction of certain organs on irritation occur which strikingly suggest a correspondence of function between them and the motor organs of animals. Among the most remarkable are those of *Drosera* and some other plants belonging to the same natural order, particularly the well-known Venus's Flytrap (*Dionæa muscipula*). The Sensitive Plant, the Common Monkey Flower, the Rock Cistus, afford other examples.

Whether these contractile movements are accompanied with the same electrical changes as those which occur in the contraction of muscle and in the functional excitation of nerve has never yet been investigated by vegetable physiologists. Mr. Darwin, who for many years has devoted much attention to the animal-like functions of *Dionæa* and *Drosera*, kindly furnished plants for the purpose of the necessary experiments, which have been made by Dr. Sanderson in the laboratory of University College, London. The result has been that the anticipations he had formed have been confirmed as to the existence of voltaic currents in these parts, and particularly in the leaf of *Dionæa*. By a most remarkable series of experiments (which will be published subsequently) made with the aid of Sir W. Thomson's galvanometer, he has shown that these currents are subject, in all respects in which they have been as yet investigated, to the same laws as those of muscle and nerve.

SOCIETE D'ENCOURAGEMENT POUR L'INDUSTRIE NATIONALE.

At a meeting of the Council of Administration of this Society, under the presidency of M. Dumas, a letter from Sir Charles Wheatstone was read, who said, in acknowledging the Ampère medal conferred upon him by the Society in March last, "If my efforts have in any degree aided to accomplish the end sought by your Society, it is because science and industry have between them so intimate a relation that all progress in the one is almost necessarily accompanied by a corresponding progress in the other. Indeed, the arts in an early and imperfect state doubtless have taken their origin in the first principles obtained by scientific research; but easy deductions are as easily exhausted, and the progress of future industrial art will depend upon new discoveries in science, and upon new developments of scientific knowledge already acquired."

Count Du Moncel's report upon Arlincourt's Relay was accepted by vote, and ordered to be printed in the *Bulletin*.

Electrical Science in Foreign Journals.

Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences, Vol. lxxvii., No. 12.

Thermic Researches on the Condensation of Gas by Solid Bodies; Absorption of Hydrogen by Platinum-Black.—By M. P. A. Favre.—The author wishes to show that electrolytic hydrogen is *active*, and that, in order to pass into the ordinary gaseous state, it puts in force about 4600 calories. This quantity of heat not being transmissible by the circuit, the allotropic change of hydrogen occurs, and to this class of phenomena the term *meta-electrolytic* is applied. In his researches on the absorption of hydrogen by palladium, the author has made known—1. The quantity of heat (about 9000 calories) due to the formation of the alloy of hydrogenium and palladium; 2. That the condensation of hydrogen by palladium, and the condensation of gas by carbon are not in the least compatible. The method of condensation of hydrogen by platinum-black differs from that of hydrogen by palladium in plates. When the gas is introduced in successive portions into contact with the platinum-black until saturation is attained, the heat developed is not constant for the weight of gas absorbed, as takes place with palladium. Hydrogen indeed appears to form a true alloy with palladium, whilst with platinum-black it seems to form only layers of less and less density as it enters the metal. The action of platinum-black upon hydrogen appears to fall under the head of capillary affinity. The author repeats that he has been led to the conclusion that *oxygen* is not an immediate product of elec-

trolysis, but of the decomposition of the radical metalloid SO_4 at the positive electrode. Also that in the electrolysis of alkaline bases the water is decomposed by the radical metalloid of the salt, constituting a *synelectrolytic* phenomenon, as well as decomposed by the radical metal of its composition; that is to say, the heat put in force aids the current. The reasoning tends to establish that hydrogen entering into the constitution of acids is there in an active condition. Is it the same for hydrogen that enters into the constitution of water? It is to be thought so. The hydrogen of water (a non-electrolytic body) cannot be obtained directly by electrolysis, but indirectly as in the above synelectrolytic phenomenon. It will be seen that the thermic phenomena of the formation of water and those of its decomposition are not as simple as would appear at first sight. Indeed, in separating the elements constituting water in its ordinary state, the quantity of heat shown by the calorimeter is the algebraic sum of the numbers furnished by the following phenomena: 1. Passage of the hydrogen and oxygen, ordinary and gaseous, to the active and equally gaseous condition; 2. Combination of these elements as modified; 3. Final transition of the vapour of water to the liquid state.

Chloride of Lead Battery.—A Note, by M. Pierlot.—At the bottom of a glass or earthenware jar place about 500 grammes of chloride of lead. On this a plate of lead, with a wire of the same metal, the wire passing through the liquid being insulated by varnish. Then a plate of zinc amalgamated, and wrapped in a bag of dialysing paper. Water is to be added two or three times a month. The current is constant and energetic.

Les Mondes. Vol. xxxii., No. 4.

Experiment on Magnetism.—By M. Ruhmkorff.—In making use of the apparatus of M. Le Roux, after completely enclosing the disc in magnetism, neither resistance nor heat were obtained. If a portion of the disc were pulled off, great resistance obtained; one Daniell element gave sufficient resistance to render turning difficult, but if this resistance be conquered, heating does not take place. Thinking that perhaps a current of air cooled the disc, I caused the apparatus to be enveloped in a wooden case, but without effect. I replaced the disc, which was 0·15 centimetre diameter by one much smaller, of 0·08 centimetre. It was then necessary, in order to have a marked resistance, to employ two large Bunsen elements; turning for twelve minutes, the disc became very hot. If surrounded completely as in the first instance, neither resistance occurred nor heating took place. This shows that for heating effect a certain quantity of magnetism is necessary.

Sitzungsberichte der Kaiserlichen Academie der Wissenschaften, Vienna. October, 1873.

The Influence of Electrical Forces on Non-Conducting Substances.—By M. L. Boltzmann.—Helmholtz's theory of dielectricity appears to show that electric forces may exercise considerable attraction on a non-conductor simply through dielectric polarisation; that a non-conducting ball in a homogeneous electric field should be $\frac{d-1}{d+2}$ times as strongly attracted as a similar and insulated conducting ball affected by means of induction; d being the constant of dielectricity. A first series of experiments were made to determine the value of d for rubber, sulphur, paraffin, and resin. A second series included the following experiments:—A ball of the insulating substance was hung by a silk thread at the arm of a delicate balance whose motions were indicated by a small mirror. Near this movable ball was a fixed one which could be charged from a machine with either positive or negative electricity. For the non-conducting ball an equal sized conducting one could be substituted. A second balance with conducting ball suspended near the fixed ball served to measure the quantity of electricity. Comparison was now made between the attractions of the non-conducting and the conducting balls on the first balance. The numbers show that the conducting ball was much more attracted than the non-conducting one. According to the theory of dielectrics these numbers should have the value $\frac{d+1}{d-2}$ The values of d deduced are compared with those from the former measurement. It was observed that the longer the electric action the more considerable was the dielectric polarisation. M. Boltzmann thinks his method should yield valuable results on the hitherto little studied behaviour of insulators in the electric field. The author further views his numbers in connection with Maxwell's hypothesis that light and electricity are different forms of motion in one and the same medium. Between the dielectric constant, d, and the refractive index, i, of any substance, Maxwell obtained the relation $i = \sqrt{d\mu}$, where μ is the coefficient of magnetic induction. This coefficient in the four above mentioned substances cannot be very different from air, which is taken as $=1$. So that we have the index of refraction equal to the square root of the constant of dielectricity. M. Boltzmann accordingly compares the square roots of these constants as found by his method with the refractive indices as determined by Wollaston's method; and the differences may be attributed to errors of observation. He considers these results, though not so accurate as to lead to the identification of light and electricity, furnish strong support to Maxwell's theory.

Bulletin du Musée de l'Industrie de Belgique. September, 1873.

Report on the Systems of Pneumatic Tubes Employed in England for the Transport of Telegraphic Despatches to Short Distances.—By M. F. Delarge, Telegraph Engineer.—(A Review, by M. Gauthy.)—Given elsewhere.

The Journal of the Franklin Institute. Vol. lxvi., No. 3.

The American District Telegraph Company.—The apparatus employed by this company is described in another portion of this journal.

Lightning and Lightning-Rods.—By John M. Mott.—Continued in our next number.

Scientific American, Vol. xxix., No. 13.

The Multiplex Telegraph.—On page 64 of our current volume, we called attention to an article in a contemporary, describing a French invention by which four operators can, it is asserted, each work a telegraphic communication over a single wire in one direction simultaneously; and not only this, but four others can operate at the same time in the other direction. A correspondent, J. T., writes to inform us (*The Scientific American*), that the honour of this invention belongs to the United States, and that the original and only inventor of the system by which more than two telegraphic instruments can be worked at the same time over one wire is Mr. Merritt Gally, of Rochester, N.Y., the inventor of the "Universal" printing machine. Mr. Gally's telegraph improvement has been patented in the United States and in some European countries. Our correspondent states as follows:—"By the use of Mr. Gally's invention a large number of operators at different stations along a single wire can be simultaneously employed sending different messages in either or both directions without conflict, each accomplishing as much or more work than would be possible

for him to do by the use of the Morse key. Mr. Gally has adapted his system to each and every kind of receiver or register. The operator can receive his letter in print or by sound, or both simultaneously; or by the embossing, marking, or the electro-chemical recorder; and his instruments are so simple and accurate in their manipulation that it seems impossible that a mistake could occur in their operations. No time whatever is wasted in adjusting the instruments. They are always in readiness, and the first stroke of the operator sends the first letter of his message. Each touch of the key-board represents a letter or other signal complete. The operator may be sending a message to a distant station, be receiving another from an intermediate or more distant station, and through a third part of his instrument be in active communication with every office on the line, receiving or sending calls or explanations; while on the same wire numerous other operators, all along the line, may be similarly employed. By using the electro-chemical recorder, on Mr. Gally's system, at least sixty operators may be simultaneously employed upon a single wire sending messages to any destination along the line; thus entirely doing away with the necessity of previously preparing the messages in punched slips of paper, as is done for the automatic machine." *The Scientific American* hopes soon to publish full particulars and illustrations of this last addition to and improvement in telegraphic apparatus, the capabilities of which multiply with astounding rapidity.

Lecture Experiments in Electricity.—An extract from a series of papers, entitled, "The Magic Lantern as a Means of Demonstration," by Professor H. Morton, Ph.D.—If a piece of thick platinum or tin wire is bent into a hoop circling the interior of one of the glass tanks above mentioned, and the tank itself is filled with a strong solution of bichloride of tin, then, on inserting another wire at the centre of the solution and connecting with a series of two or three Grove's elements, so as to make the centre wire the negative and the hoop the positive pole, a beautiful growth of metallic crystals will shoot out from the centre, and spread over the entire surface of the field. A similar experiment may, of course, be performed with a vertical tank, but the unsupported weight of the metallic blades then soon breaks them down. In this arrangement, however, they are supported perfectly, resting, in fact, on the bottom of the tank, as the solution should not be more than an eighth of an inch deep. If a small compass-needle be mounted on a pointed support, like an inverted tack or drawing pin, its motions are, of course, vastly amplified in the huge image projected on the screen, and may thus be utilised in a number of ways which are too evident to need mention and too numerous to admit of it. If, moreover, a piece of covered copper wire is bent into a flat rectangle and placed beside the needle, with its ends, of course, in binding screws or mercury cups, it will form a galvanometer quite delicate enough for all ordinary use. It will indeed show the induced current developed by introducing a magnet into and withdrawing it from a helix. This, of course, opens a wide field of illustration. A more complete apparatus for use as a lantern galvanometer has been described and used by Professor A. M. Mayer, of the Stevens Institute of Technology, with great success, but as it involves several modifications in the constructive detail of the instrument, we must refer the reader to the Professor's original description. (See *American Journal of Science*, 1872, vol. iii., p. 414; *Journal of the Franklin Institute*, 1872, vol. lxiii., p. 421; and "The Earth a Great Magnet," Chatfield and Co.) Another arrangement, superior to this for many purposes, and not requiring a vertical lantern, has since been devised by Professor Mayer, and will be found described in *American Journal of Science and Arts*, 1873, vol. v., p. 270.

City and Commercial Notes.

Messrs. Grant Brothers, as bankers and agents of the River Plate and Brazil Telegraph Company, are now offering for subscription £91,000 share capital of this company, in 4550 shares of £20 each, to be issued at par, being the balance of £391,000, the capital required for the completion and working of the whole of the land and submarine cables undertaken by the company. By the statutes of the company, the authorised share capital amounts to £600,000, but advantageous arrangements have been entered into by which the total requisite expenditure will be limited to the amount mentioned above, and, of this, £300,000 has already been subscribed. An exclusive privilege has been granted by the Imperial Government of Brazil for a period of forty years, by the terms of which, power is reserved to the Government to purchase the cables at any period after the expiration of ten years, upon the advantageous terms of paying for the same on the basis of the amount of the earnings of the five previous years; the cable reverting to the Government at the expiration of the terms of the concession; and a reserve fund of 10 per cent of the earnings will be created with a view of providing for the repayment of that portion of the capital represented by the cables. Messrs. Siemens Brothers have already manufactured upwards of 700 miles of the cables, leaving only about 430 miles to be completed. The specifications of the cables have been prepared by Sir William Thomson, F.R.S., and Professor Fleeming Jenkin, F.R.S. The Montevidean Government have granted a concession authorising the construction and working of a network of land lines throughout Montevideo. The construction of the land lines has been entrusted to Messrs. Lamas and Co. The calls on the £20 shares now offered will be payable as follows—viz.: £1 on application, £4 on allotment, and £5 on the 1st of December, January, and February next, interest at the rate of 6 per cent being allowed up to the 15th April next, by which time it is anticipated that the whole of the cables will be duly laid, and cable communication established from the states of the River Plate to Rio de Janeiro, Bahia, Pernambuco, and Para, and dividend will then accrue. It is calculated that the amount of British capital alone invested in River Plate and Brazilian securities and enterprises is between 50 and 100 millions sterling. It is evident that a more rapid means of communication is demanded; when the entire system of telegraph to Europe is complete, communication will be reduced from over forty days to a few hours.

The Eastern Telegraph Company's traffic receipts for the month of September, 1873, amounted to £33,162, and to £29,303 in the corresponding period of 1872.

The Eastern Extension, &c., Telegraph Company's traffic receipts for the month of September, 1873, amounted to £19,128.

The Eastern Extension, &c., Telegraph Company have declared an interim dividend for the quarter ending the 30th June, at the rate of 6 per cent per annum, or 3s. per share, free of income-tax, payable this day.

A memorandum from the Secretary of the Globe Telegraph and Trust Company, Limited, says:—"I am instructed to state that interim dividends of 1½ per cent, or 3s. per share, upon the fully paid preference and ordinary shares of this company for the quarter ending 18th October current, and on the preference and ordinary shares not fully paid, at the rate of 6 per cent per annum on the amounts paid up from the respective dates of the payments, to the same date, will be paid on the 18th inst. The transfer books will be closed from the 15th to the 19th inst."

TELEGRAPH SHARE LIST.

Amount per Share.	Name of Company.	Amount paid up.	Closing Quotations.
£		£	Oct. 14.
Stock	Anglo-American (Limited)	100	87¼—88¼
10	Brazilian Submarine..	9	2—1½ dis.
10	Cuba	All	8⅞—9¼
10	Direct Spanish	9	¼dis.—¼pm
20	Direct United States Cable	11	6—4 dis.
10	Eastern (Limited)	All	8¾—9
10	Ditto New	All	8¾—9
10	Eastern Extn. Australia and China	All	8¾—9
10	Great Northern	All	9¾—10
25	Indo-European	All	15—17
10	Mediterranean Extension (Limited)	All	5—5¼
10	Do., 8 per cent Pref...	All	11—12
8	Reuters	All	10¾—11¼
Stock	Submarine	100	245—255
1	Do., Scrip	All	2¼—2⅜
10	West India and Panama	All	6⅜—6¾
10	Do., 10 per cent Pref.	All	10½—11
20	Western and Brazilian (Limited) ..	All	13—15
1000 dls.	West Un. U.S. 7 per cent 1st M.B.	All	92—94
10	Hooper's Telegraph Works	All	11¼—12¼
50	India-Rubber and Gutta Percha ..	All	31—33
Cert.	Submarine Cables Trust	100	112—115
12	Telegraph Construction	All	31⅞—32¼
100	Ditto Ditto 7 per cent Bonds	100	102—105

The receipts of the Submarine Telegraph Company for the month of September amounted to £8,828; these receipts, as compared with £9,118—those of the corresponding month last year—show a decrease of £290.

The total traffic receipts of the Great Northern Telegraph Company have been during September, 1873, 324,338 francs, and, in the corresponding period of 1872, 230,462 francs. On the European lines—in 1873, 151,094 francs; in 1872, 131,972 francs. On the China and Japan lines—in 1873, 173,244 francs; in 1872, 98,490 francs.

The directors of Reuter's Telegram Company, Limited, have declared the usual interim dividend at the rate of 5 per cent per annum, for the half year ending the 30th June last, payable this day.

In speaking of the return of the *Great Eastern* without having been successful in the repair of the Atlantic Cable of 1865, Mr. William Abbott remarks that the expedition has not been barren of results which will have an important influence on the future of submarine telegraphy. From the specimens of the 1858 and 1865 cables which Captain Halpin, the able commander of the *Great Eastern*, has brought home, it is evident that submarine cables are less affected by age than was generally supposed. The necessity of duplicate lines on all important routes is now also clearly established. The cables themselves are proved to be capable of bearing the strain of being lifted, but the certainty of having weather favourable enough for that delicate operation cannot be assured, and therefore, as duplicate lines have become absolutely essential in the interest of commerce and civilisation, it is obvious that the telegraphing public must pay for this extra security.

The shares of the Globe Telegraph and Trust Company are now being actively dealt in on the Stock Exchange. The ordinary shares are quoted at about £8, and the six per cent preference at ¼ premium, or £10¾. In return for this preference security the latter give to the ordinary shares all the extra dividends beyond 6 per cent. For instance, taking the average dividends received on the securities held by the Trust at 7 per cent, the Globe ordinary stock will, by the addition of this 1 per cent relinquished by the preference, receive a distribution of 8 per cent.

The first section of the Brazilian Cable has been completed, and will shortly be out of the contractor's hands. This line will begin at once to earn a revenue in connexion with the intelligence to and from this country and Ashantee.

Messrs. Grant, Brothers, and Co. announce that, in accordance with the option reserved to the bondholders, the half-yearly coupon No. 3, due 1st November next, on the seven per cent first mortgage building bonds of the Western Union Telegraph Company will be cashed at the fixed exchange of 4s. per dollar, equal to £7 per coupon, on and after date, at their banking-house, 24, Lombard-street.

Speaking of Deep-Sea Telegraphy, a correspondent of the *Times* says:—"In the early days of this branch of enterprise investors naturally felt timid at buying shares in cable companies whose property seemed liable to sudden extinction from the peculiar risks to which it was exposed. That a cable fault could be first localised with precision and then removed with certainty was too much to expect. Then again the period for which a cable would remain serviceable was an unknown quantity, and its liability to the ravages of marine insects or to injury by the sharp edges of deep-sea precipices was a material item in calculating its permanent value. As far as the durability of the insulating material is concerned it is now tolerably certain that though the *Teredo navalis* is most destructive to wood and other substances it has no liking for gutta-percha, and contents itself generally with the slightest surface nibbling. The testimony of experience, derived from the results of 20 years, goes to show that this substance suffers nothing from immersion in sea water. On the other hand, it is known that the great pressure to which a deep-sea cable is subjected tends to increase the density and consequently the efficiency of the insulator. Three broken cables have of late been recovered from deep water, the direct Spanish, the Jamaica—Colon and the Madeira—Lisbon. The first was fractured by a submarine landslip, and successfully grappled for in a depth of 1500 fathoms. The second was broken three years ago, recovered and repaired last autumn, broken again shortly after, and has now just been reinstated. The broken end had to be fished up from a depth of 1700 fathoms, or about two miles of water. The third cable mentioned above has just been repaired and laid, after being lost between Lisbon and Madeira. In the case of a fourth cable, the Atlantic of 1858, which has been silent for 15 years, it is known that the Great Eastern, in her search for the broken 1865 cable, hooked up a part of the first-named, and that it is reported to be locally in a good state of preservation. The big ship, it is true, has not succeeded in repairing the later cable, and it was thought better to await the return of a calm sea and clear weather next year, but enough has been learnt of the condition of the line to warrant the belief that the renewed attempt will be successful. To us, however, it seems open to question whether the Great Eastern, unrivalled, perhaps, as a cable-holding and cable-laying instrument, is not less well-adapted for cable-finding, and much less economical, than some smaller and handier vessel. Of all the instances we have given, perhaps the most noteworty, and certainly the most creditable to our national reputation for bull-dog tenacity, is the cable connecting Jamaica with the Isthmus of Panama. The difficulties attending the picking-up expedition were unexampled in telegraphy. When the contractors had, in spite of all that skill and the best appliances could do, lost the cable in a storm, and grappled for it a reasonable time, they would have been justified by precedent in considering themselves released from any further obligations. However, the India-rubber Company held on loyally to the work they had undertaken, in spite of all obstacles; and there is no reason to doubt that the other great cable-making firms would do likewise. So long as this is the case, the public may feel confidence in the successful issue of these important operations."

Patents.

3802. W. Moseley, of Liverpool, Telegraph Engineer. *Improvements in Governors for Marine and other Engines.* Dated December 16, 1872.—My invention is chiefly designed to afford the means for more perfectly controlling the working of the engines of ocean steam vessels, and more particularly to prevent the "racing" of the engines of screw propellors, which ordinarily occurs when through the pitching of the vessel in rough seas the screw is raised out of the water. I connect with the levers of the throttle valve a slide which remains stationary except when thrown into gear with another slide that is continually moved to and fro by means of a belt connected with the engine-shaft. I arrange an electro-magnet or a pair of such magnets over the said slides, and when the circuit is made through the magnet, the slides are connected and the throttle valve is opened or closed. The electric circuit is made and broken by a swinging arm, which is moved by the pitching of the vessel. In some cases I may combine with the aforesaid apparatus a small governor of any ordinary construction, arranged to complete the circuit in case of accident to the engines.

453. Augusto Guattari, of Buckingham Palace Road, in the county of Middlesex. *Improvements in Pneumatic Telegraphs.* Dated February 7, 1873. My invention relates, first, to an improvement in the pneumatic telegraph apparatus for which I obtained Letters Patent, No. 2797, 1871, and consists in a modification of the transmitting instrument by the application to the air conducting tube of a regulator by which the air contained therein may be compressed more or less as required, so as to regulate the tension of the air according to the distance to which the signal is to be transmitted instead of varying the movement of the transmitting bellows or piston. My invention relates secondly to an instrument which serves either as transmitter or receiver. The needle working over the dial is operated by an anchor propelment, and the instrument comprises a compressible air bag or bellows for transmitting when the index needle may be worked by a spring push rod acting on the anchor propelment, or by the pressure of the air in the line or conducting tube. For receiving, it is actuated by the movements of a rod connected to a flexible diaphragm on the end of a branch tube connected with the main tube so as to be inflated or vibrated by the impulse of the air in the tube. The invention related thirdly to an arrangement of the combined transmitting and receiving instruments specially adapted for use on board ship; such instruments are disposed at different parts of a ship, with any one of which the captain's instrument may be made to communicate by means of a commutator cock.

474. R. Werdermann, of Princes Street, Surrey, Civil Engineer. *An Improved Mode of Reducing Metals from their Ores and Purifying and Refining the Same.* Dated February 10, 1873.—My said invention relates to an improved mode of applying electric currents in order to reduce metals directly from the ores with or without the ordinary chemical action of carbonaceous matter, and in purifying and refining at the same time and by the same process the metal during its reduction from the ore.

476. R. Werdermann, of Princes Street, Surrey, Civil Engineer. *An Improved Mode of and Apparatus for Purifying and Refining Metals and Alloys.* Dated February 10, 1873.—My said invention consists in an improved mode of applying electric currents to remove the noxious elements mixed or combined with the metal or alloy, and to permit such noxious elements when required to be collected and purified; it also consists in improved apparatus whereby the currents are effectually employed.

490. A. M. Clark, of Chancery Lane, Middlesex. *Improvements in Railway Signalling Apparatus.* A communication from Paul Tesse, Henry Lartigue, and Pierre Désiré Prud'homme, all of Paris, France. Dated February 10, 1873. The electric apparatus is actuated by the working of the signal arms by a handle in such manner that the apparatus will indicate both when a train enters upon and quits a block or section of the line, in addition, in the case of single lines, to showing whether the line is clear or blocked by a train travelling in the opposite direction.

523. R. Lyon, of Bristol, Gloucester. *Improvements in Apparatus for Communicating between the Passengers and Guards, and between the Guards and Engine Driver of a Railway Train.* Dated February 12, 1873. This invention consists of bellows fitted to each compartment of a railway train, such bellows communicating with a pipe extending along the entire length of the train, and provided with a whistle at each end, the same pipe forming also a speaking tube between the guards and driver. On pulling down a handle in any one of the compartments, the whistles are sounded, and at the same time a signal is shown indicating in which compartment the apparatus has been used.

528. C. W. Harrison, of High Holborn, Middlesex. *Improvements in Obtaining Oxygen.* Dated February 12, 1873. This specification describes obtaining oxygen from atmospheric air by passing the air into suitable porous substances or by precipitating the oxygen of the air by magnetic or electro-magnetic action.

534. C. Owen, of City Road, London. *Further Improvements in Electrical Intercommunication between Passenger and Guard, Guard and Guard, and Guard and Engine Driver.* Dated February 13, 1873. When it occurs that a foreign carriage or other carriages not fitted with my apparatus as described in my Specification, No. 3512, Nov. 23rd, 1872, have to be attached to a train already so fitted, I adopt the following means to complete the circuit of electrical communication throughout the train:—Two screw clips are made to clamp on the eave of each end of the carriage, to which clips are clamped two gutta-percha covered copper wires running from end to end of such carriage or carriages. On each clip are fitted two eyes or rings, each of which is attached to one train wire. A stout spring being fastened to the screw clip and pressing on the said eyes or rings ensures perfect contact when the carriages are coupled together. In the event of any of the carriages becoming disconnected by accident, the guards are apprised of the fact by means of a metal plate being screwed at the top end of such coupling, and when such coupling becomes perfectly taut, the metal plate is brought into contact with two brass studs fixed at the bottom of coupling box, which studs being connected to train wires complete circuit of electricity when brought together and cause bells to ring in guards' vans. When a carriage or carriages have to be slipped and left at any given station or siding, I make use of the slip coupling as follows:—The ordinary coupling wires are separated in the centre and two telescope tubes are introduced, the inner or sliding tubes are sprung, and a tipping piece soldered on the end slips into a groove turned inside the outer tube when the inner tubes are pushed home, thus preventing accidental slipping caused by the motion of the train, but are readily self released on sufficient tension being applied when the carriages are required to be slipped.

545. H. Highton, M.A., of Putney, Surrey. *Improvements in Electric Telegraphs.* Dated February 13, 1873.—This Provisional Specification describes special arrangements by which the gold-leaf instrument is applied advantageously to work long lines, especially where the insulation is defective.

UNITED STATES.

140,011. Robert Carter, New York. *Fire Alarm Telegraph.* Application filed October 24, 1872.—By means of an earth connection at each box and an earth from centre of battery, an earth circuit can be made to central office whenever metallic circuit is broken, an alarm apparatus being upon each side of battery.

140,923. Albert Janor, Regent's Park, England. *Pneumatic Telegraph.* Dated March 26, 1873. The transmitting air chamber is provided with a valve controlled by a peculiarly formed cam on the operating crank or index shaft, so as to equalise the pressure at each pause or rest in the signalling. A notched plate, against which a light spring from the diaphragm lever is pressed, serves to give precision to the movements of the receiving index.

140,924. John A. Jeançon, Newport, Ky. *Electro-Deposition of Aluminum.* Dated November 1, 1872. Dissolve the desired salt of aluminum or a double salt of aluminum and potassium, sodium, &c., in distilled water, and concentrate to 20° Baumé (at 50° Fahrenheit). The battery used is either four parts of Smee's zinco-platinum or three Bunsen's zinco-carbon, the elements connected for intensity. The solution is heated to 140° Fahrenheit, slightly acidulated, and a plate of aluminum is attached to the negative wire in working.

140,953. David Rousseau, New York, assignor to himself and Wm. C. Smith, same place. *Circuit Closer for Railroad Signals.* Dated April 9, 1873. Placed underneath rail between ties; the flexure of rail pressing down and closing circuit; rubber cushion holding them apart normally.

141,395. Henry W. Spang, Reading, Pa. *Electric Railway Signal Apparatus.* May 11, 1872. Geissler tube used for visual signal at night.

141,604. James G. Smith, Boston, Mass. *Railway Telegraph.* Dated March 28, 1873. Two wires in sections, one having battery connections at terminals. Sections end in a circuit changer, through which corresponding wires in adjacent sections are normally connected. Third wire controls circuit changer by current from battery in train. Arm carrying three fingers insulated from each other, one for each wire, projects from car. Train entering section operates circuit changer so that a circuit is formed from one wire through one finger to instrument on train, thence by another finger to second wire. All the trains and stations on a line may be included in one circuit.

138,993. Henry A. Chapin, Bridgeport, Conn. *Electrical Stop for Spinning Machinery.* Dated December 31, 1872. A pivoted finger, forming one electrical pole (and surrounded loosely by a sliding yoke) by resting against the thread, is kept from contact with a plate forming the other electrical pole, but, on the breaking of the thread, makes the contact, and, thus completing an electro-magnetic circuit, causes an armature detent to be withdrawn from the spring shipping lever, which thus stops the machinery. The said shipping lever, by the same movement acting on the yoke surrounding the finger, withdraws it from its contact plate, and thus immediately opens the circuit, so as to be instantly ready for the action of any other thread finger. On machines for spinning or doubling and twisting, especially, and other descriptions of machines mentioned in the specification, the combination of a circuit opener with, and operated by the shipping device, which, instantly that a thread breaks, pulls or pushes the latches or fingers off from their electrical connecting points, thus re-opening the circuit which had been closed by their falling, substantially as described.

139,128. Thomas A. Edison, Newark, N. J. *Printing Telegraph.* Dated February 18, 1873. Escapement, printing and locking electro-magnets in same circuit. Printing lever drawn away from type wheel by its magnet. Escapement magnet smaller than other two, so that when once charged it will respond to quick making and breaking of the circuit; but the others remain active from residual magnetism until there is a prolonged break in the circuit, when the locking armature releases printing lever, and the spring pulls it up against type wheel.

141,755. Robert K. Boyle, New York, N.Y. *Electric Apparatus for Signalling Railway Trains.* Dated July 1, 1873. Line wire divided into sections; polarised switches normally breaking circuit at ends of sections; battery and alarm on train. Train closes circuit to switch, causing switch to close circuit at one end; a train approaching causes switch at other end to close circuit; alarm then sounds on both trains.

AWARD OF THE GREAT AMERICAN MEDAL OF HONOUR FOR THE INVENTION OF THE DUPLEX TELEGRAPH.—The *Telegrapher* says: "We recently had the pleasure of inspecting the Great Medal of Honour awarded by the American Institute to Mr. J. B. Stearns, the inventor of the Duplex Telegraph. The medal is made of gold, and is beautifully executed. On the obverse, or face of the medal, are representations of the following objects in relief: The Goddess of Liberty, holding a laurel crown in her right hand, and a staff, surmounted by a liberty cap, in her left; the United States Coat of Arms, a spinning wheel, ship under sail, sheaf of wheat, shuttle, horn of plenty, plough, and the Caduceus or Mercury's rod, the symbol of good conduct, peace, and power. The rod, representing power; the serpents, wisdom; and the two wings, diligence and activity. The reverse of the medal is surrounded by a wreath of oak and laurel leaves, enclosing the following inscription: The Great Medal of Honour, awarded to J. B. Stearns for Duplex Telegraph, 1872. The honour conferred by this award, so justly bestowed upon Mr. Stearns by the Great American Institute, which occupies so pre-eminently high a position in the metropolis of the Western World, is greatly enhanced by the fact, that only one Great Medal of Honour is awarded by the American Institute during any one year, and none unless for an invention of paramount importance." Mr. Stearns, to whom America is indebted for her duplex system, is now in Europe, where we hope his great services to telegraphy will be as fully and unequivocably recognised as they have been in his native land.

TARIFF BOOK FOR FOREIGN TELEGRAMS.—Copies of a new book of the tariff and regulations applicable to telegrams sent from the United Kingdom to foreign parts, together with a list of foreign telegraph stations, can be had on application to the secretary of the General Post Office, London. Price, 2s. a copy; or by post, 2s. 3d.—By command of the Postmaster-General.—General Post Office, Oct. 13, 1873.

PRIZES TO STUDENTS.

IT has been decided to offer, from time to time, to our Students, prizes for the best and most carefully considered paper on a given subject. By the kindness and courtesy of Mr. Robert Sabine, C.E., who has placed the funds at our disposal, we are enabled to commence the series with a

PRIZE OF £25,

to be awarded to the Author of the best paper on "The Evidence of the Theory of Correlation of Physical Forces as applied to Electricity and Magnetism," received by the Editor of this Journal on or before January 1st, 1874. Each paper submitted for competition must describe original experiments. Each paper to bear (on every leaf) some word or motto by which it may be recognised. The same word or motto to be inscribed on a sealed envelope containing real name and address of competitor. The papers not selected will be destroyed with the envelopes unopened. Papers to be addressed to the Editor, and endorsed "Students' Prize." The best papers will be selected and submitted to a Committee of well-known Electrical Authorities (whose names will be published), who will award the prize for the most carefully prepared paper, irrespective of the view taken by its Author, whether favourable or unfavourable to the new theory. The award to be final. The Prize Paper to be printed in the columns of this Journal.